Impact of Terra MODIS PVLWIR Crosstalk on L1 and L2 Products

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Steve Platnick (and others): GSFC
Jack Xiong, Truman Wilson (and others): MCST

MODIS/VIIRS Science Team mtg
June 6-10, 2016

Terra MODIS PVLWIR Crosstalk

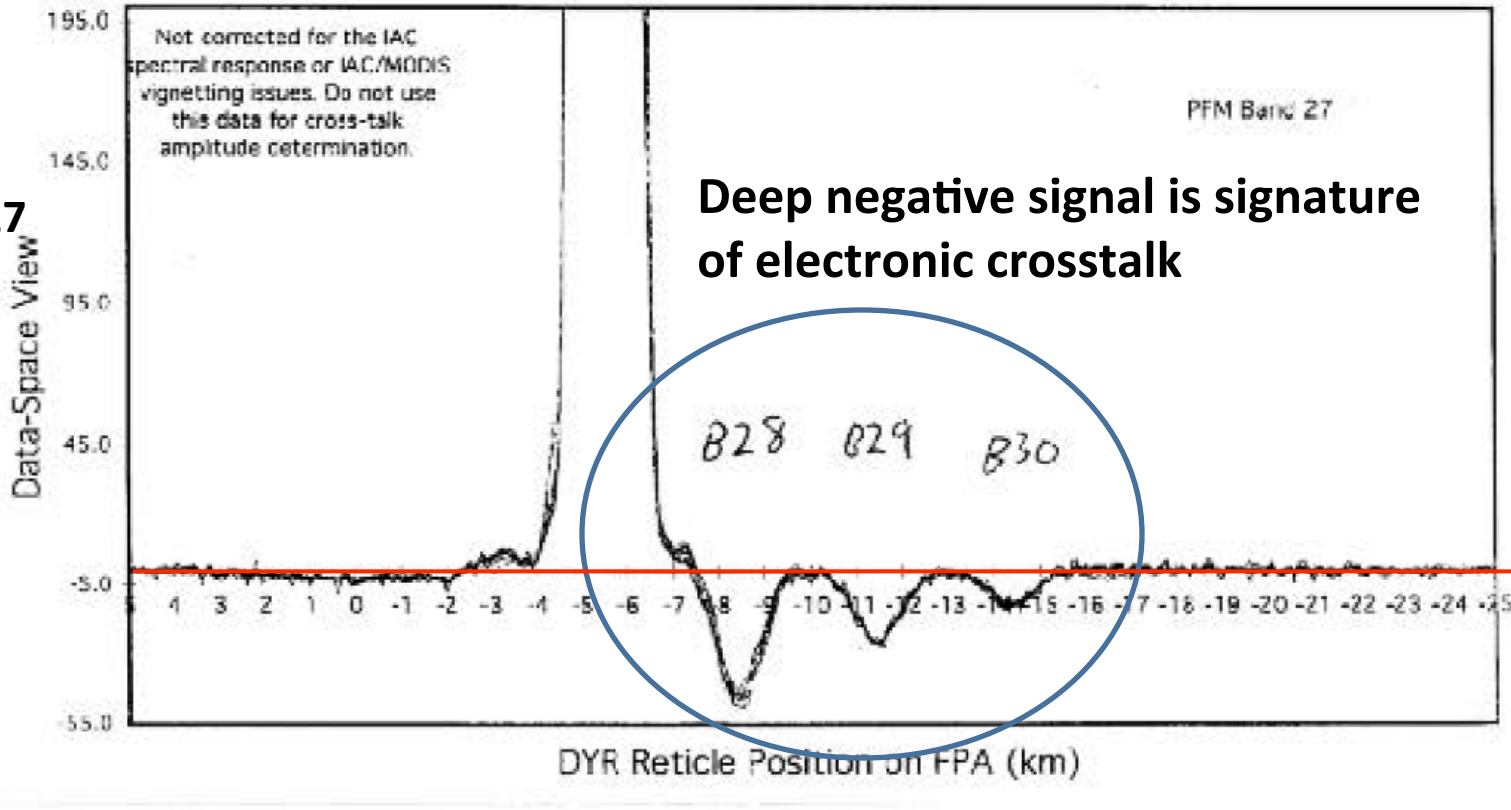
- Evidence of PVLWIR crosstalk in L1B
  - Prelaunch testing
  - On-orbit observations
- Impact on Wisconsin's L2 products
  - MOD35 (Cloud Mask)
  - MOD07 (Integrated Water Vapor)
  - MOD06 (Cloud Particle Phase, Cloud Top Pressure)
- Mitigation efforts
  - MCST-led effort to implement crosstalk correction in L1B; coordinated with Wisconsin
  - Temporarily adjust cloud test thresholds in MOD35 to minimize false cloud

Terra MODIS Crosstalk/OOB (CFPA)

Performance Issue	Impacted Bands	Status/Action
5um Optical Leak into S/MWIR	5-7, 20-26	L1B correction, updated on-orbit
S/MWIR Electronic Crosstalk	5-7, 20-26	Investigated but not expressly corrected*
PVLWIR Electronic Crosstalk	27-30	Under assessment
PCLWIR Optical Crosstalk	32-36	L1B correction

* S/MWIR Electronic Cross Talk mitigation is included in 5um optical leak correction

Earliest Evidence:
Terra MODIS (PFM) Pre-launch Testing

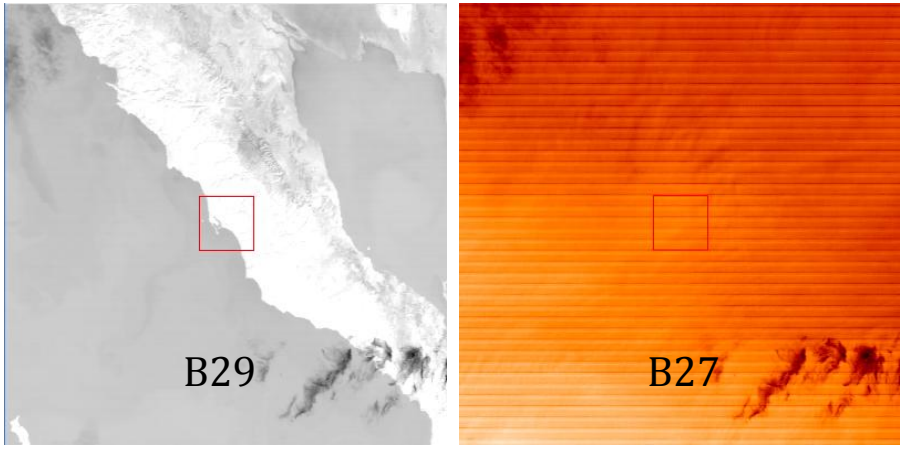


Spatial Position Along Focal Plane (Scan Direction)

From June 2000 MCST Calibration Workshop

Terra Band 27 & 29 Earth Scenes

2000355.1850



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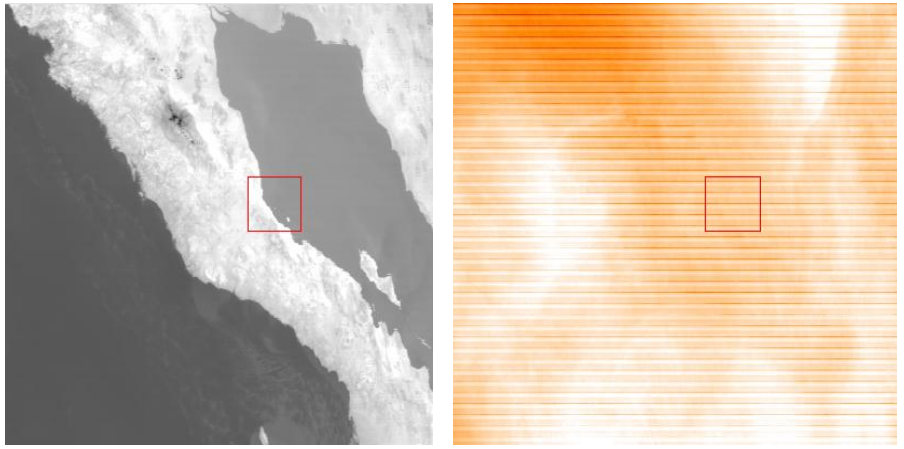

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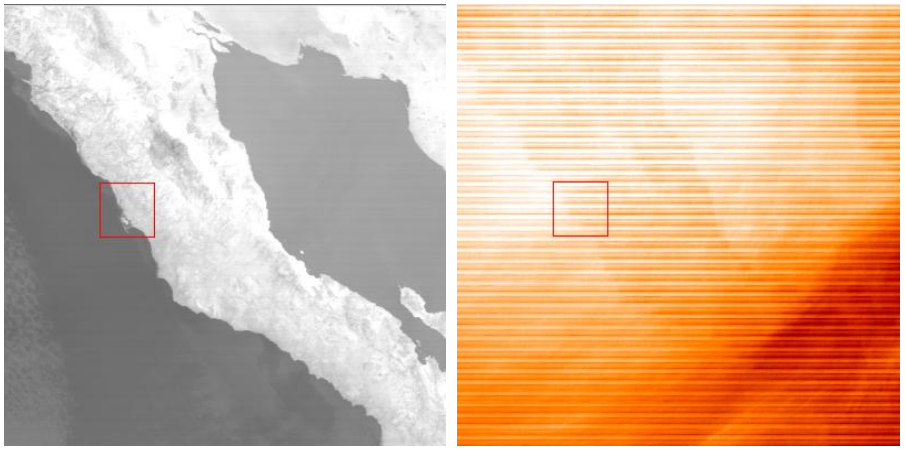

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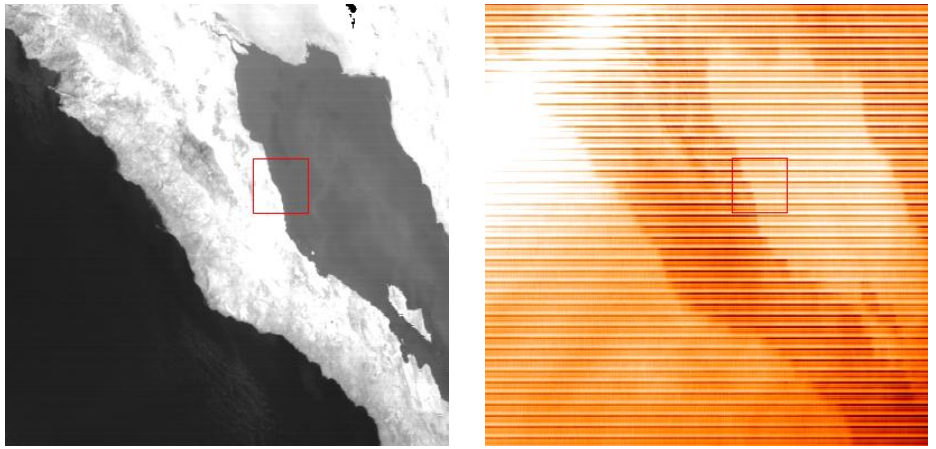


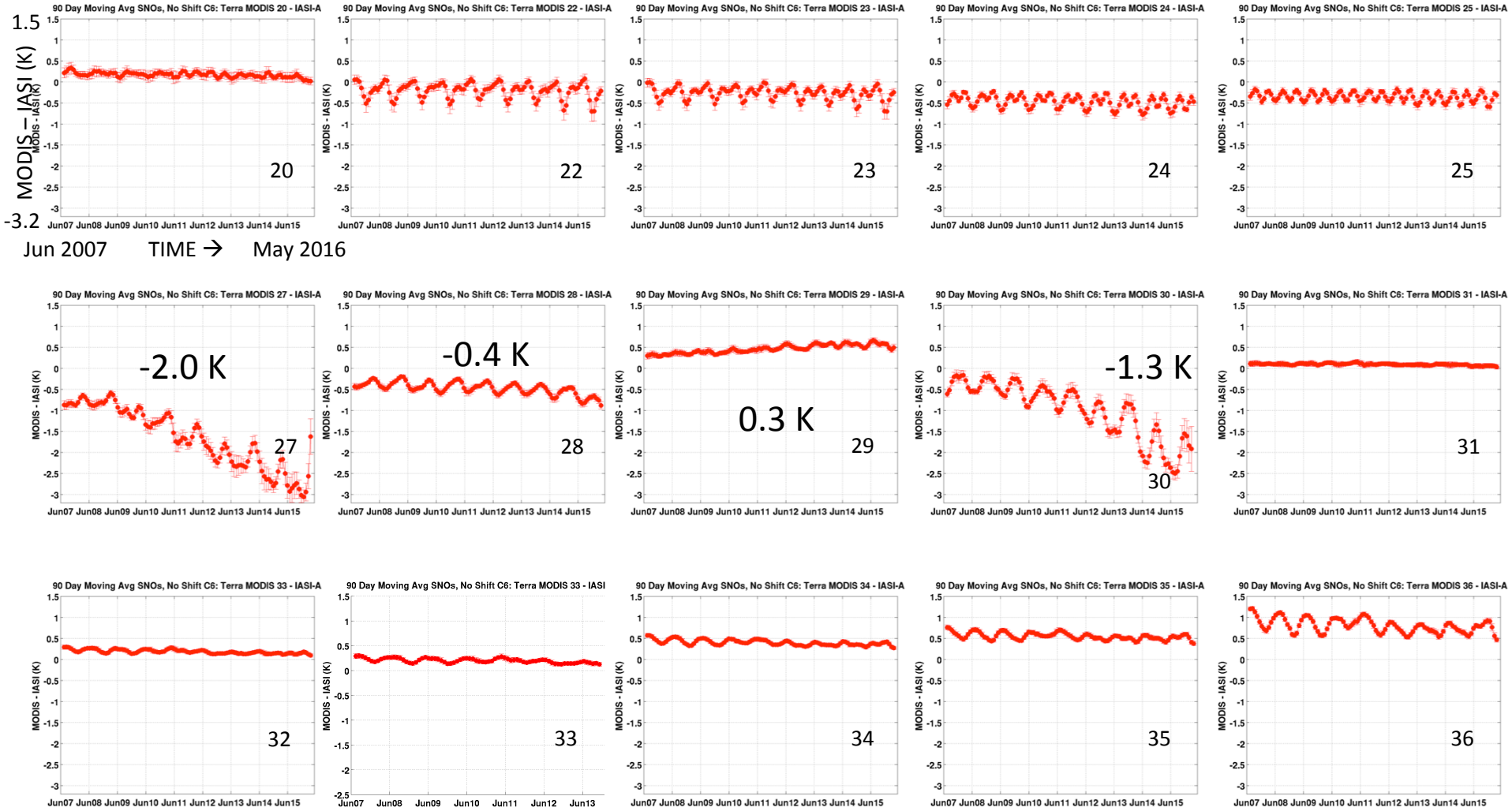
Brightness Temperature L1B images for Baja Peninsula (no stretching applied)

Borrowed from MsWG_2010_12_15_Xtalk.ppt (MCST)

Terra MODIS – MetOpA IASI Long Term Trends

(SNOs from June 2007 – May 2016; Collect 6)

Long term trends very small except bands 27 - 30

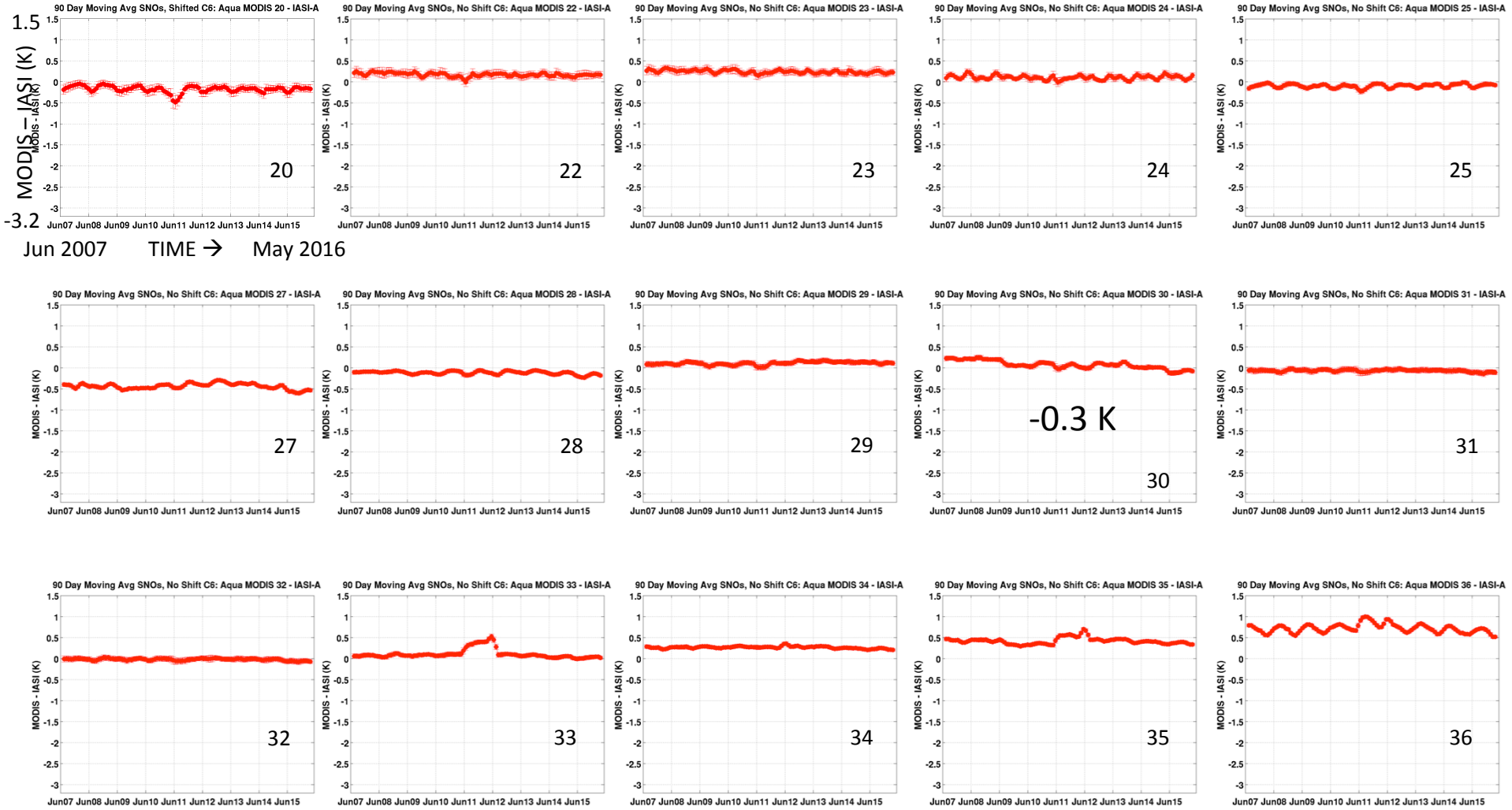


90 Day Moving Window Average Computed at 30 Day Interval

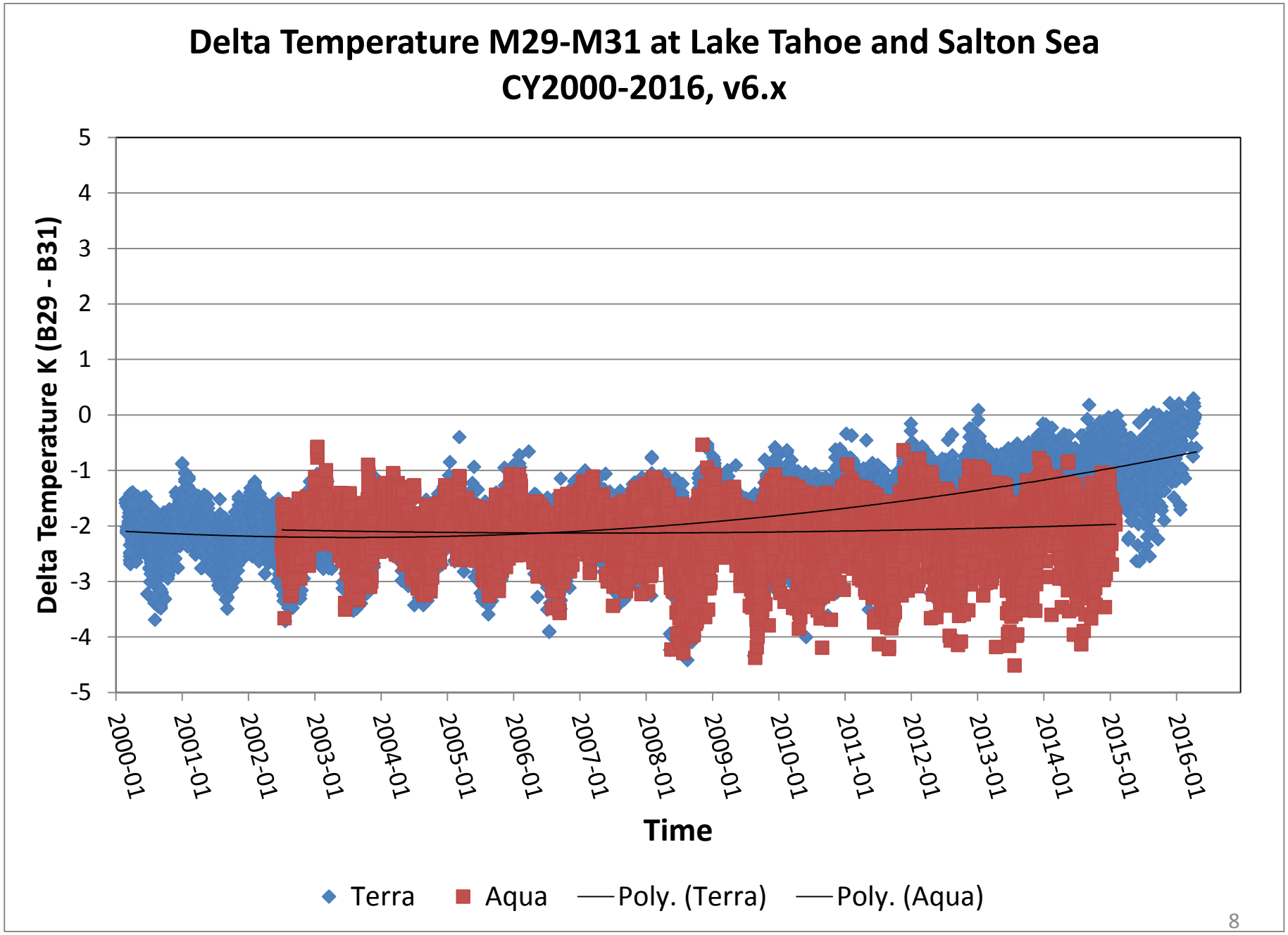
Aqua MODIS – MetOpA IASI Long Term Trends

(SNOs from June 2007 – May 2016; Collect 6)

Long term trends very small except band 30



90 Day Moving Window Average Computed at 30 Day Interval

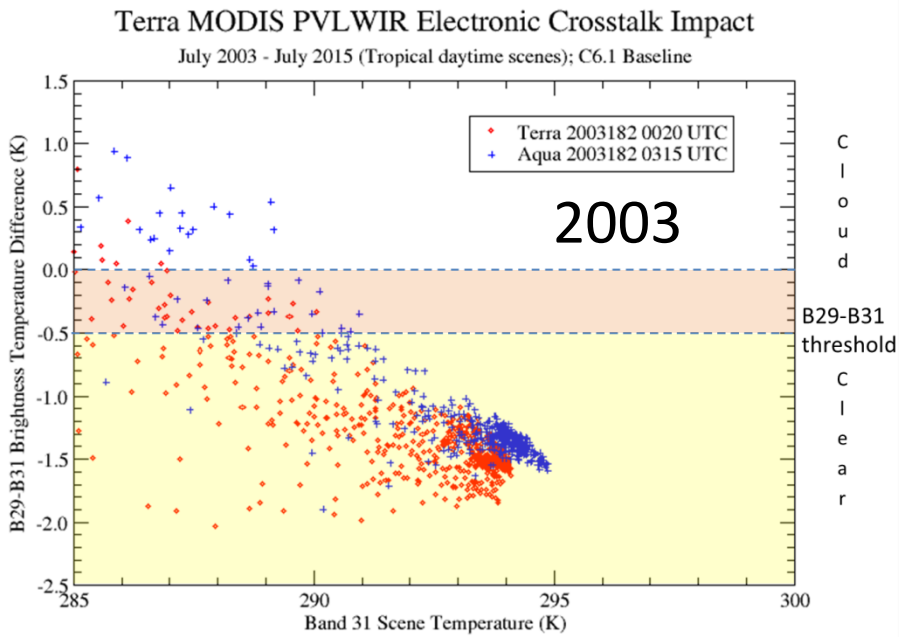


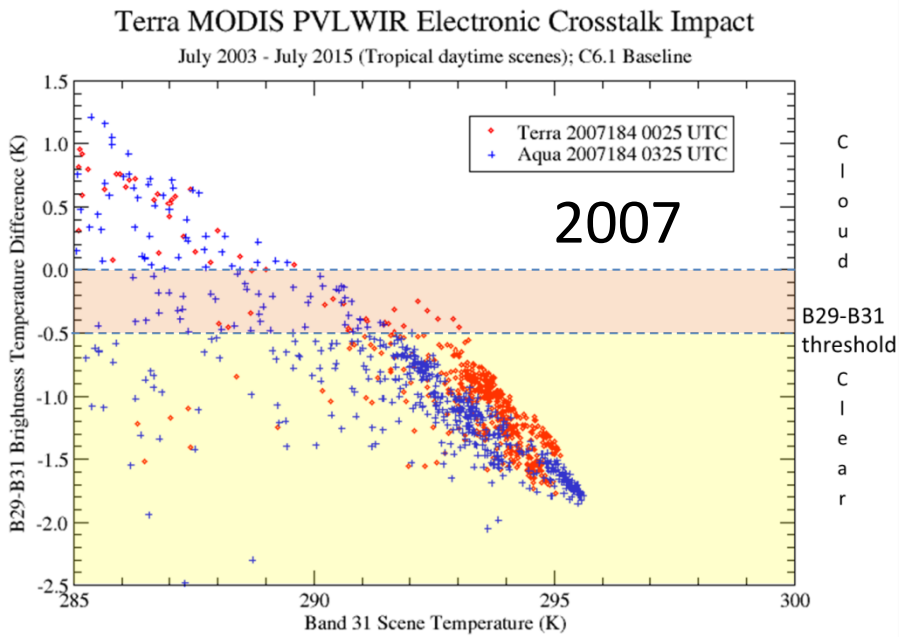
From Simon Hook, JPL

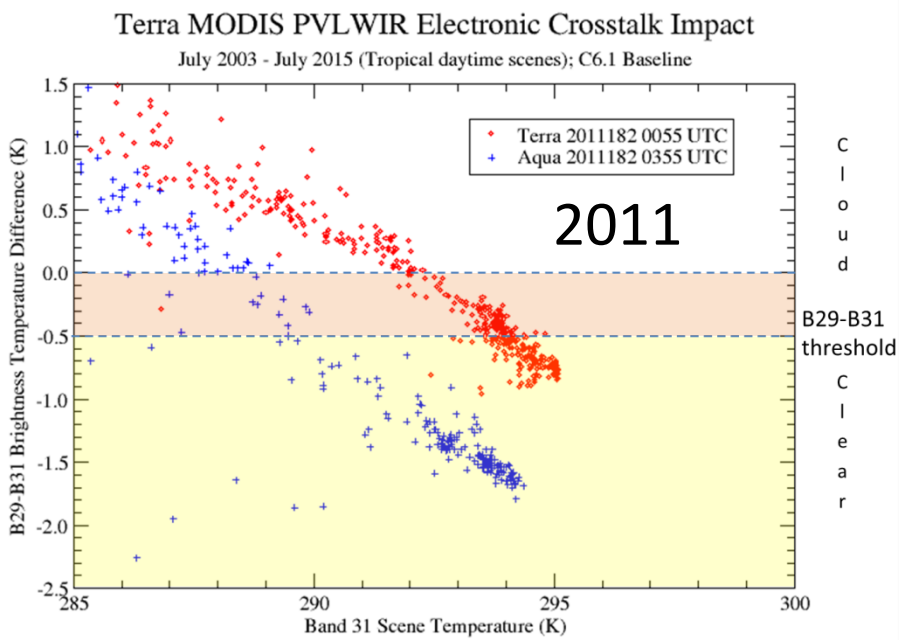
PVLWIR Crosstalk Impact in Wisconsin's Terra MODIS L2 Products

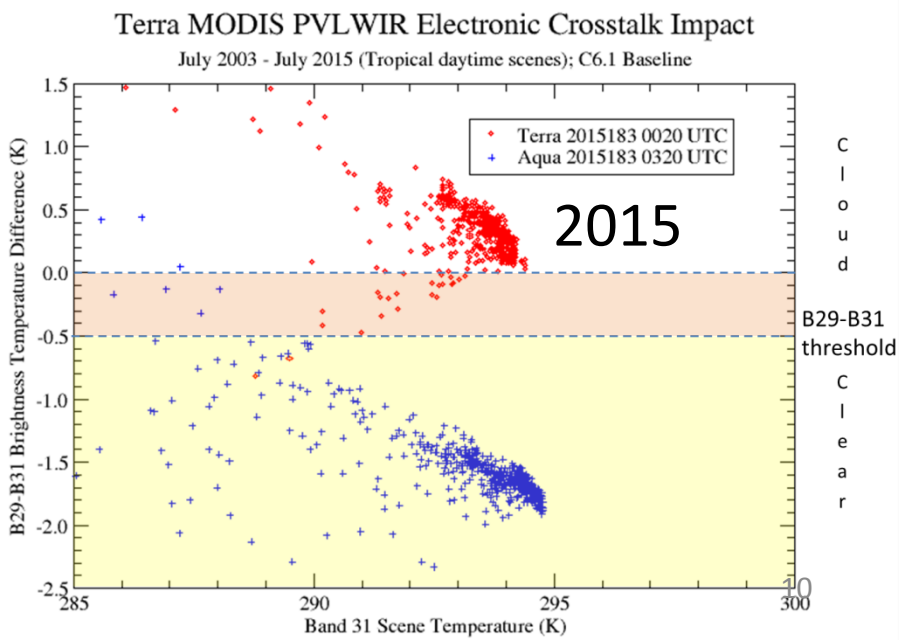
- Cloud Mask (MOD35)
  - B29-B31 BTD ice cloud test, ocean
  - B27-B31 BTD nighttime polar cloud test
  - B27 BT threshold high opaque cloud test
  - B29-B28 BTD opaque cloud test, night ocean
- Integrated Water Vapor (MOD07)
  - B27-29 contribution to moisture, B30 to ozone
  - False cloud in Cloud Mask reduces number of retrievals
- Cloud Top Properties (MOD06)
  - B29-B31 BTD contribution to Cloud Particle Phase retrieval (1- and 5-km)
  - B28-B31 BTD contribution to Cloud Particle Phase retrieval (1-km)
  - False cloud in Cloud Mask causes false Cloud Top Pressure retrieval

MODIS PVLWIR Crosstalk Impact







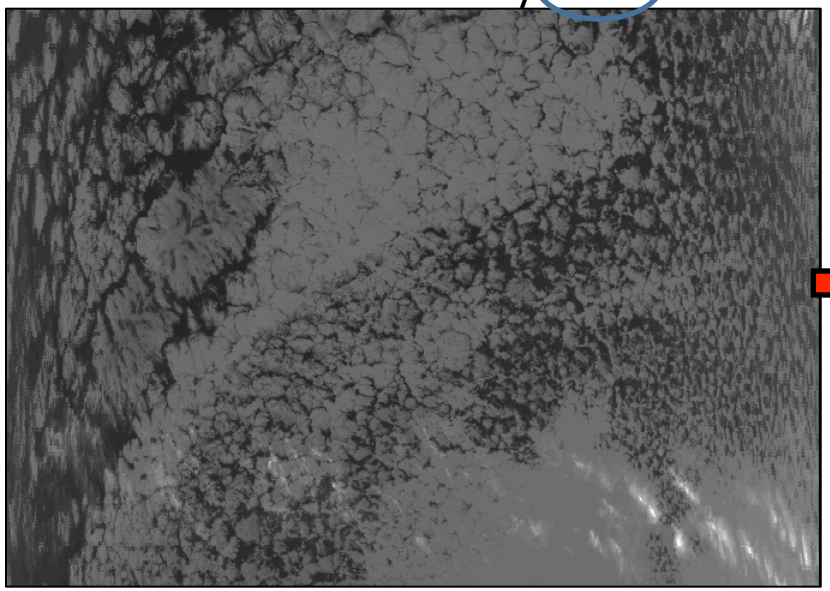


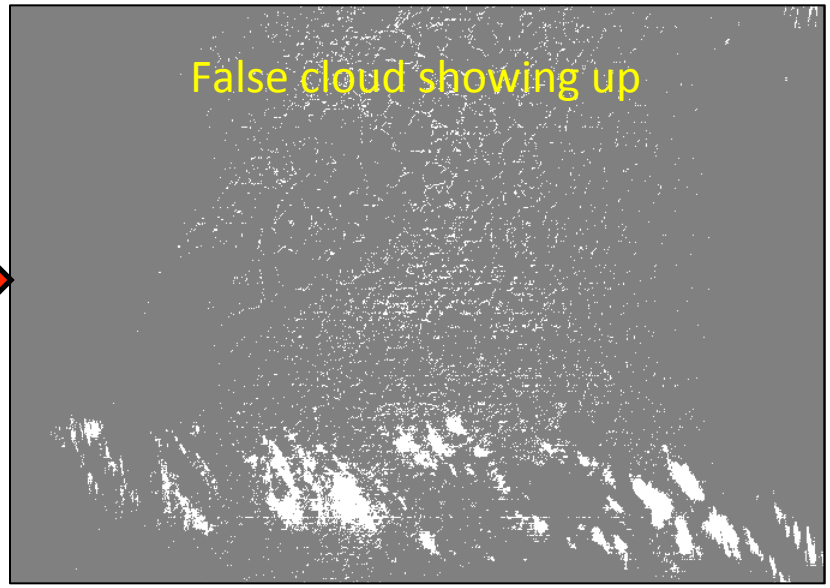
Ice Cloud Detection Test

Subtropical Eastern Pacific Ocean

16:55 UTC 01 July 2003

17:10 UTC 01 July 2013





Terra Band 31

8.6-11 µm BTD Cloud Test

Ice Cloud Detection Test

Subtropical Eastern Pacific Ocean

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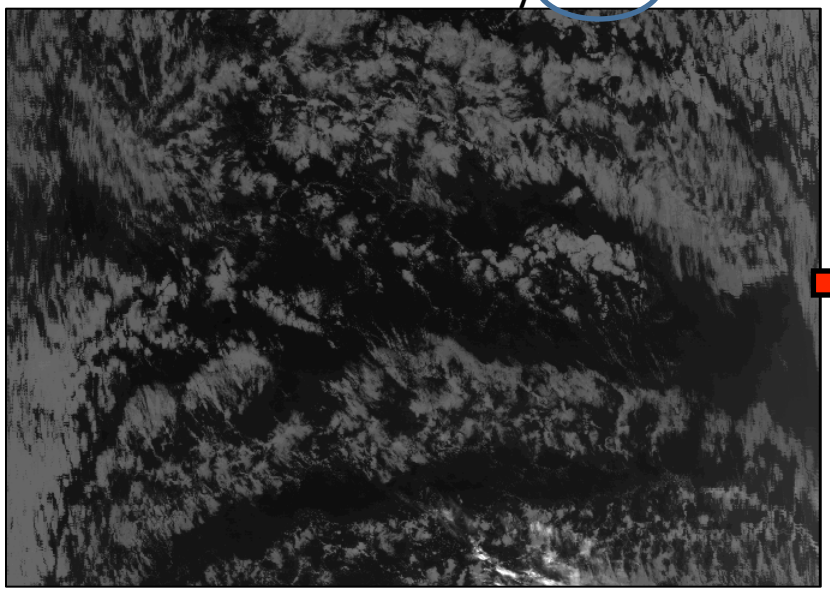
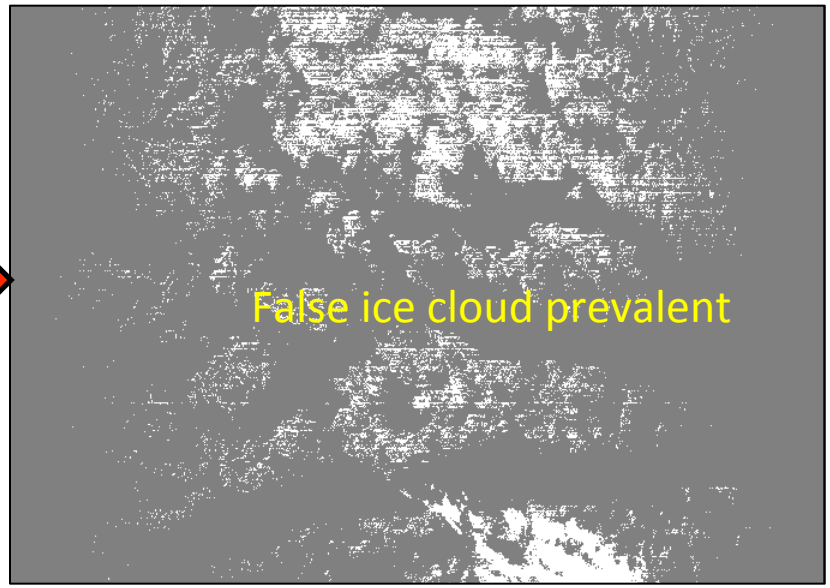
16:45 UTC 01 July 2014





Terra Band 31

B29-B31 BTD Cloud Test

Ice Cloud Detection Test

Subtropical Eastern Pacific Ocean

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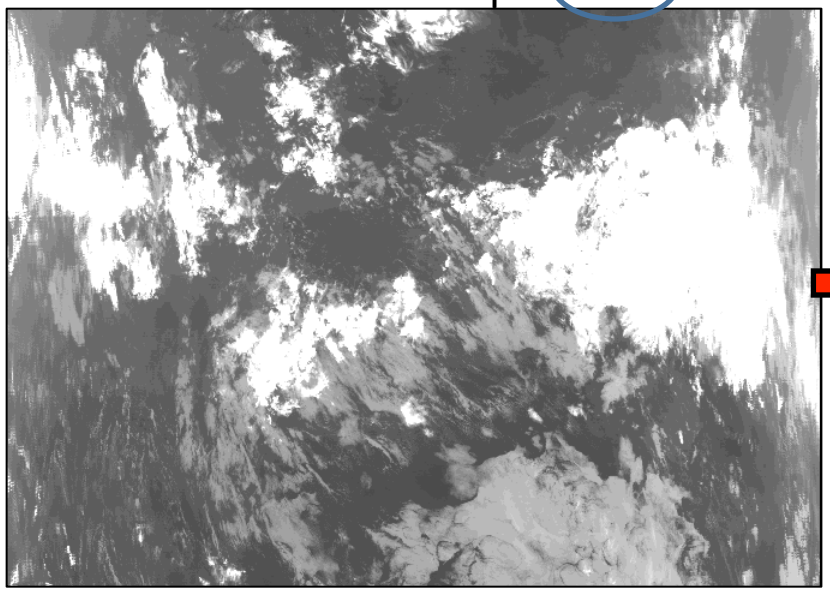
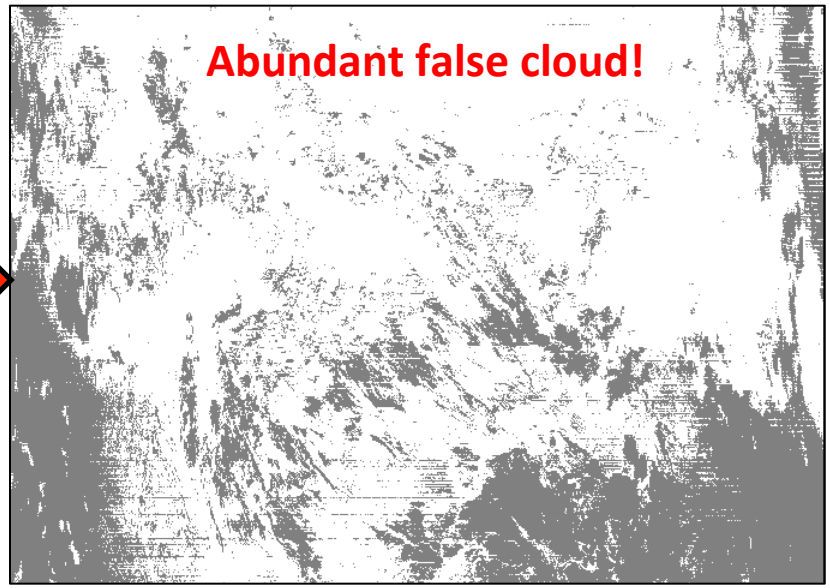
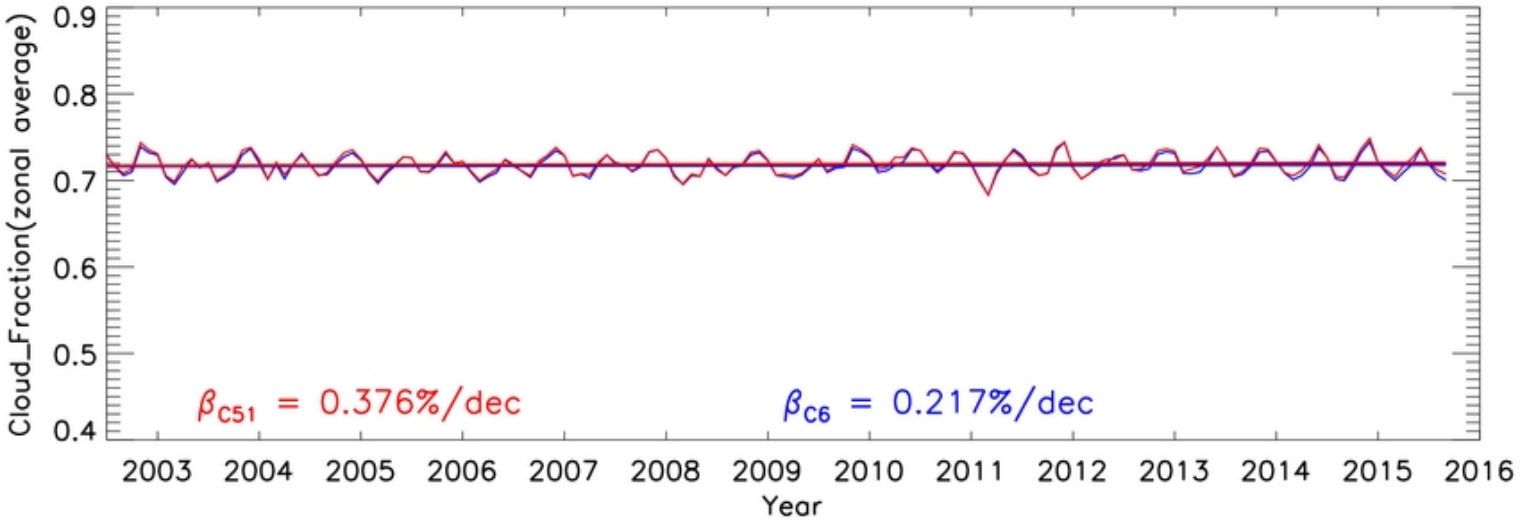




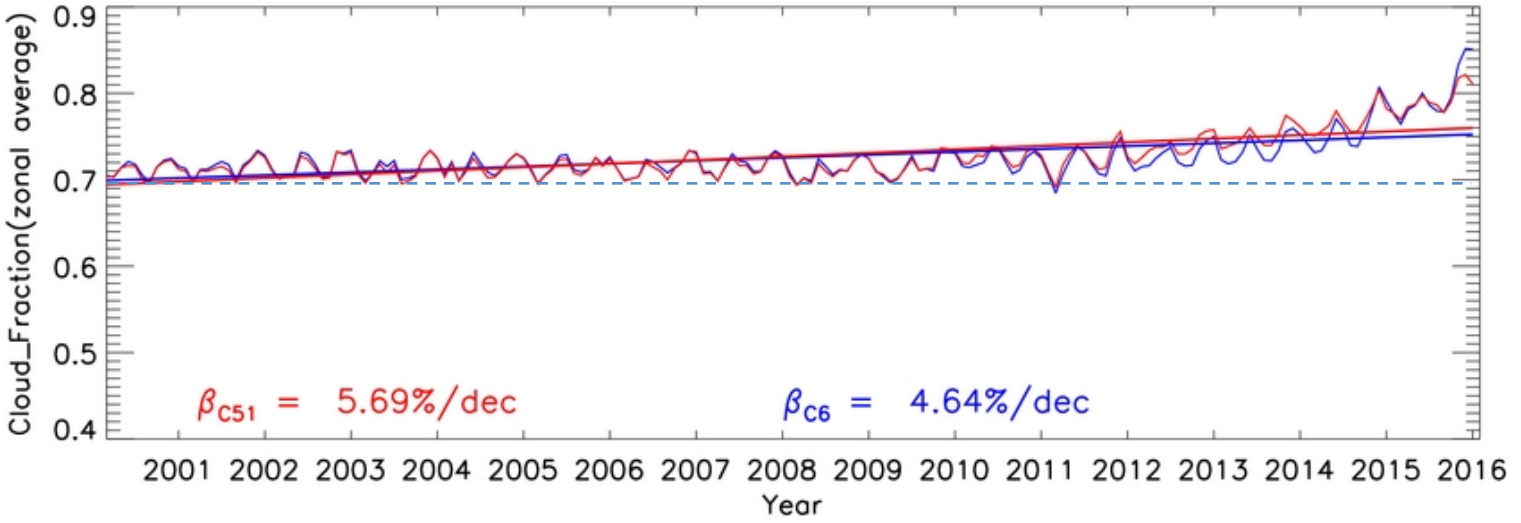
Terra Band 31

B29-B31 BTD Cloud Test

Aqua Monthly Mean Ocean Cloud Fraction, 60S-60N

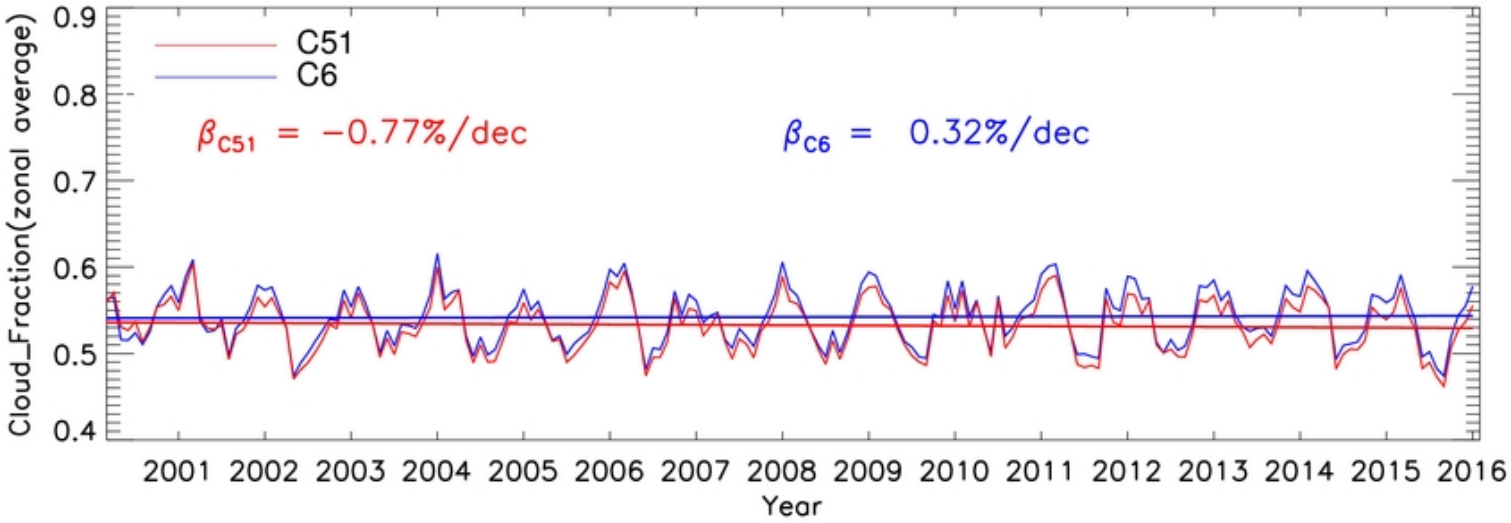


Terra Monthly Mean Ocean Cloud Fraction, 60S-60N

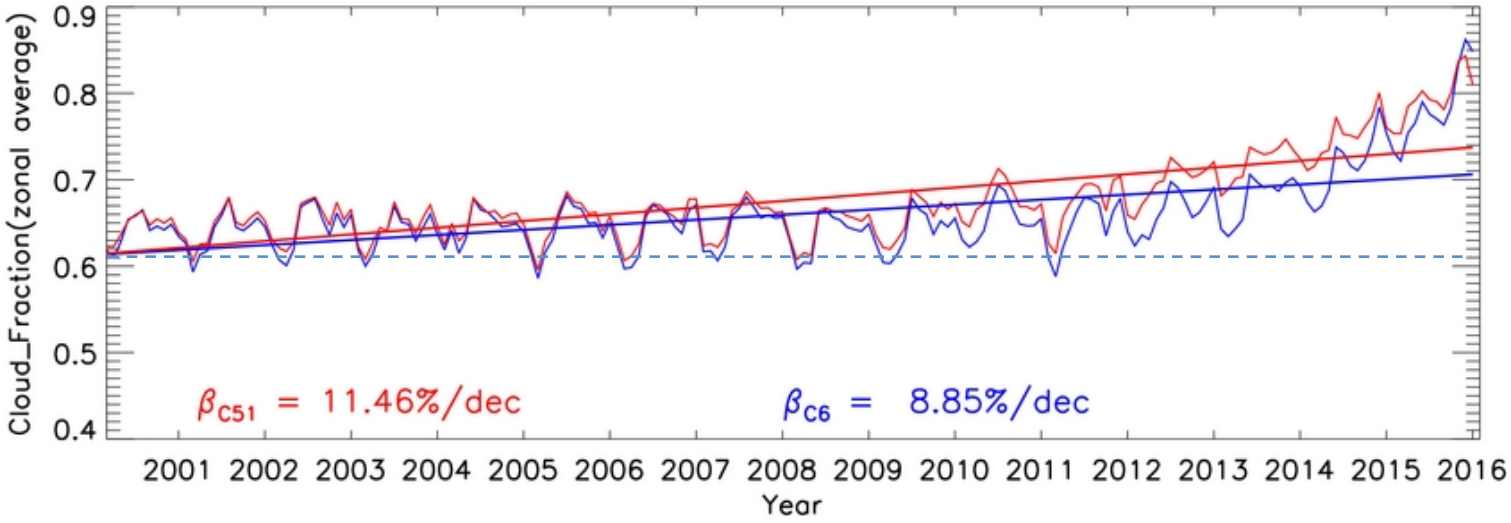


From Starry Manoharan, http://modis-atmos.gsfc.nasa.gov./IMAGES/08_Timeseries.html

Terra Monthly Mean Land Cloud Fraction, 25S-25N



Terra Monthly Mean Ocean Cloud Fraction, 25S-25N



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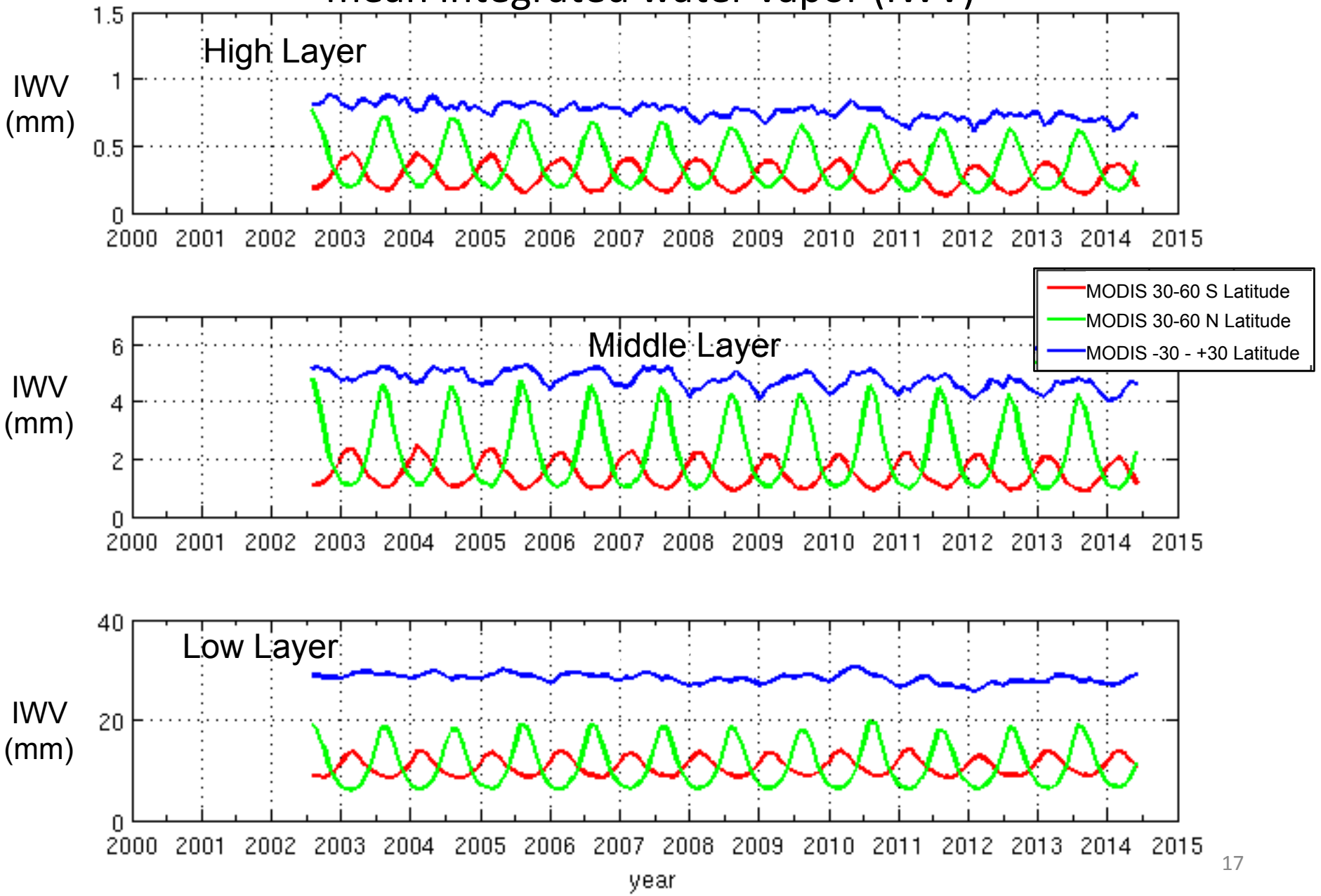
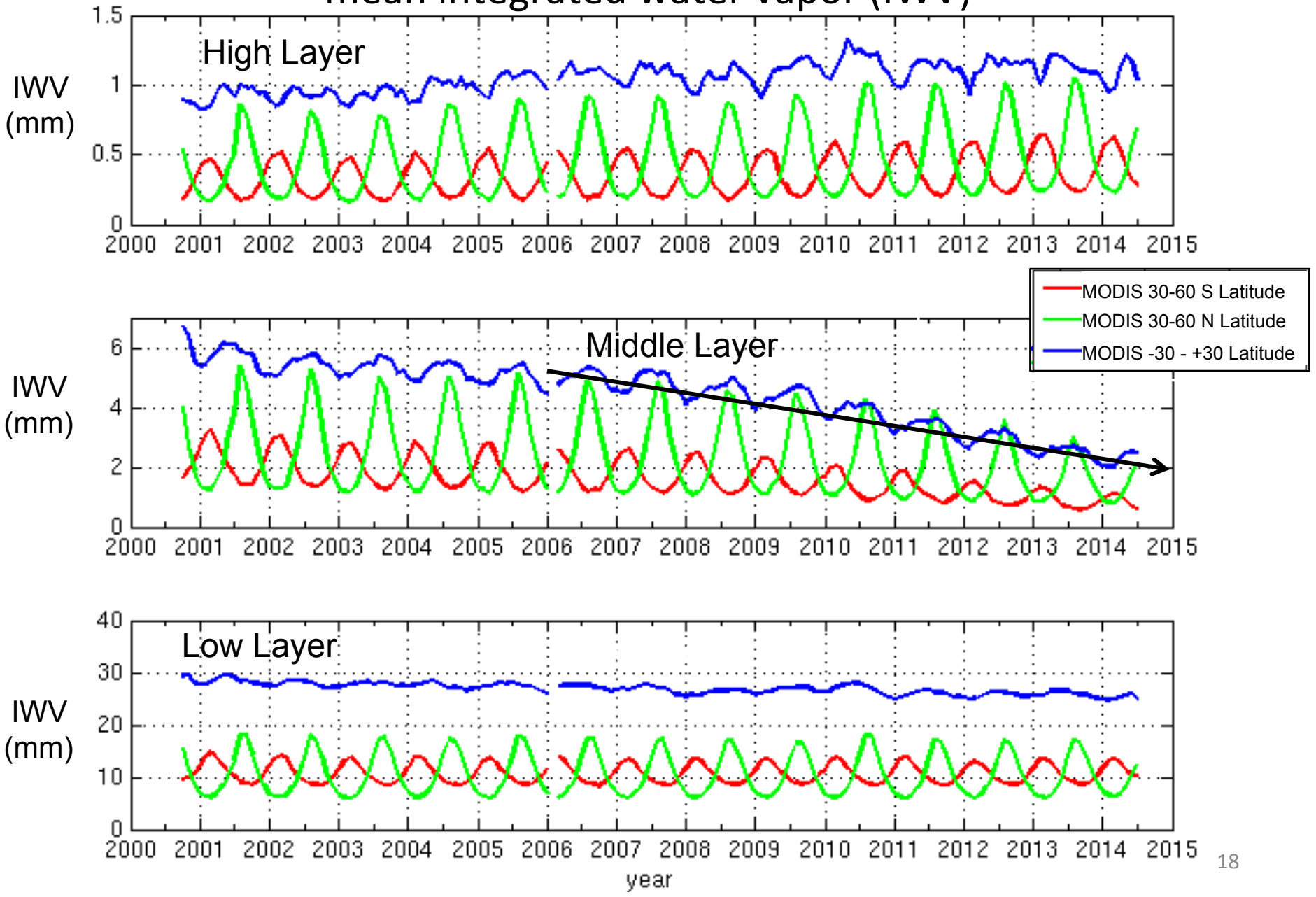
Time series of the Aqua MYD07 high, middle and low layer monthly mean integrated water vapor (IWV)



Time series of the Terra MOD07 high, middle and low layer monthly mean integrated water vapor (IWV)



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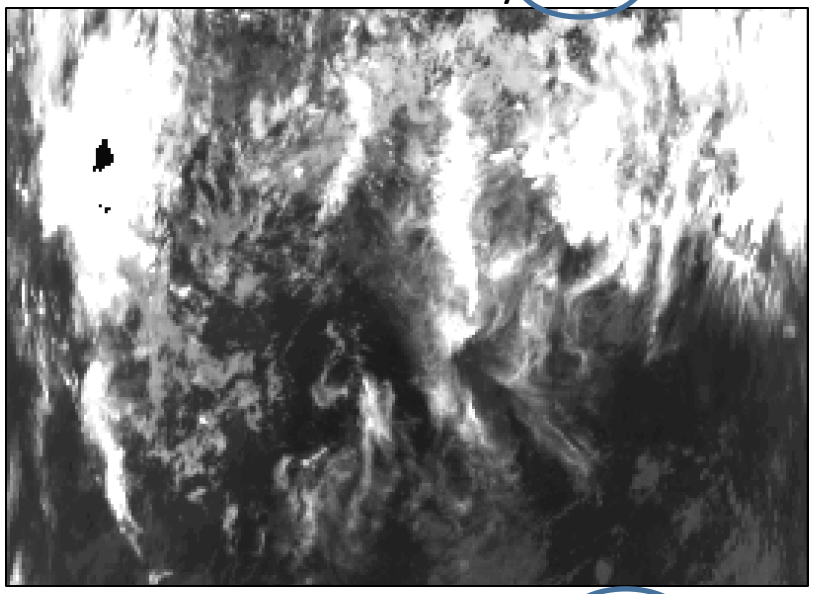
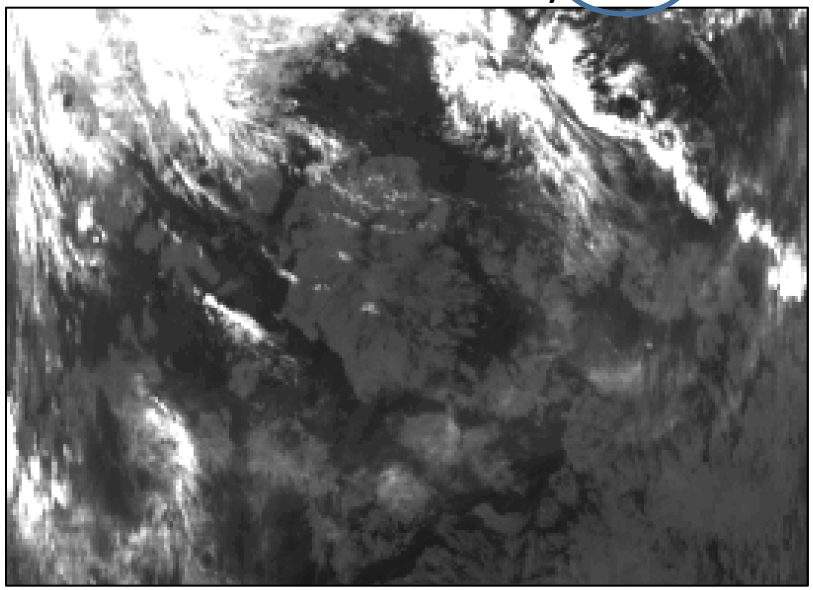
Subtropical Eastern Pacific Ocean

06:10 UTC 01 July 2003

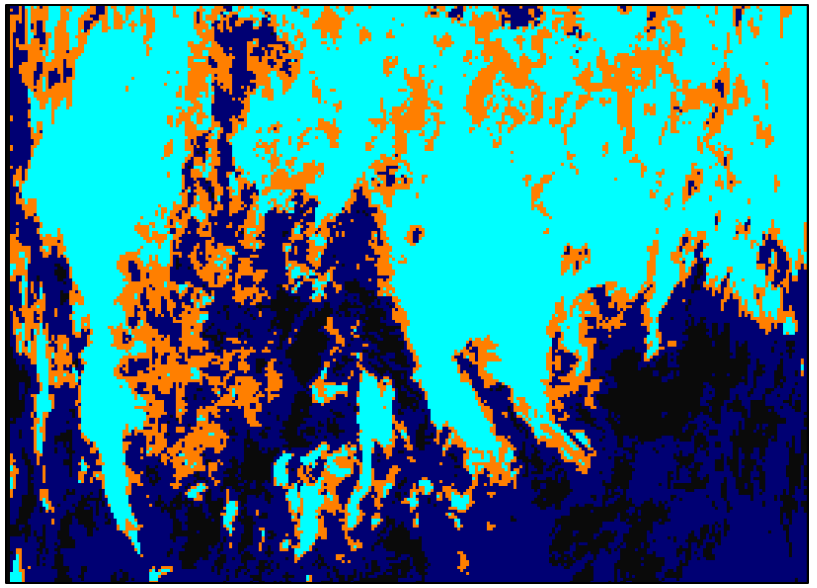


17:35 UTC 03 July 2015

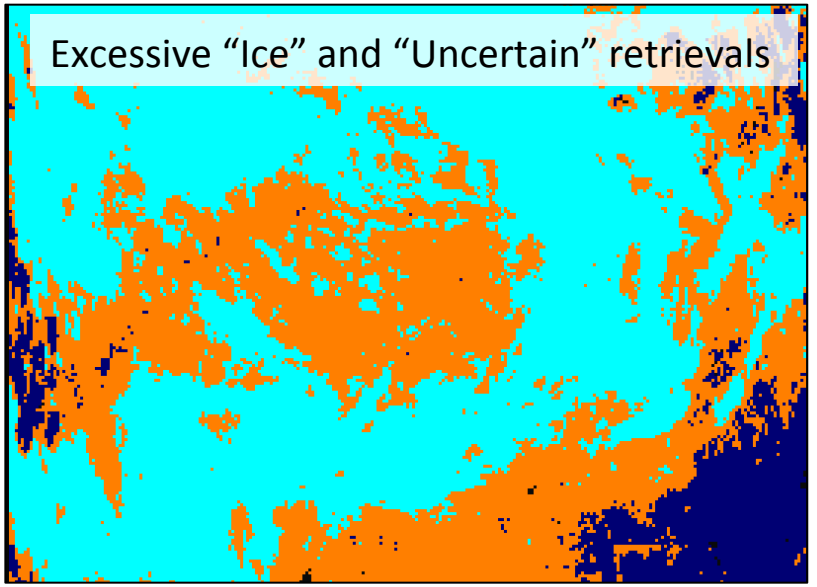


Terra Band 31

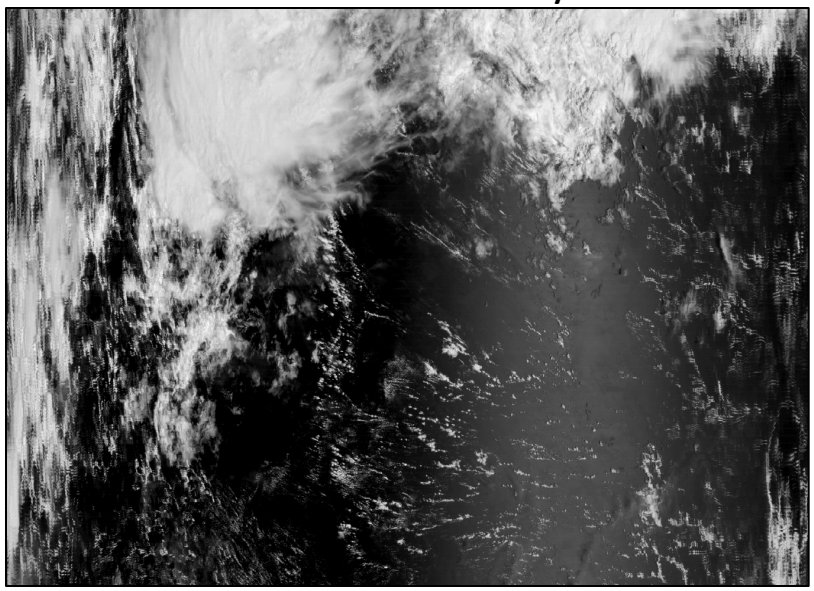
Cloud Particle Phase Result



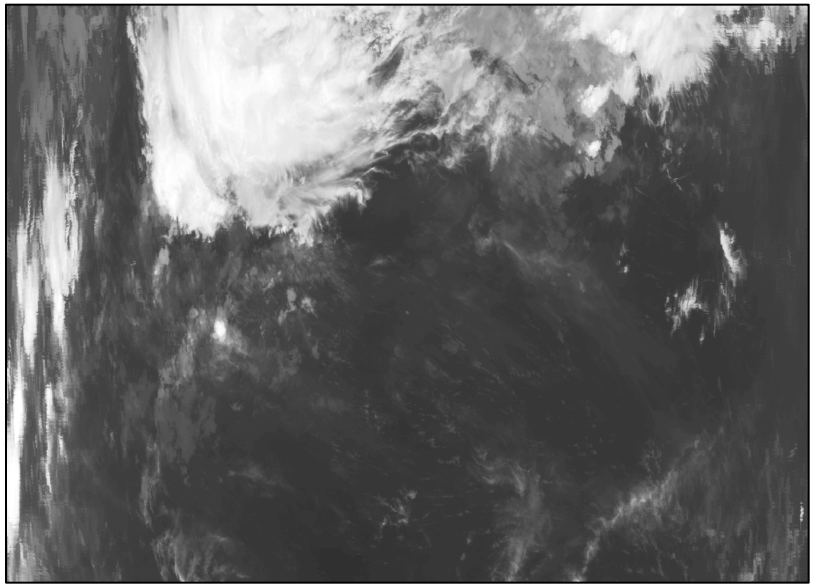
Ice Water Uncertain No retrieval



Subtropical Eastern Pacific Ocean
20:25 UTC 16 February 2016

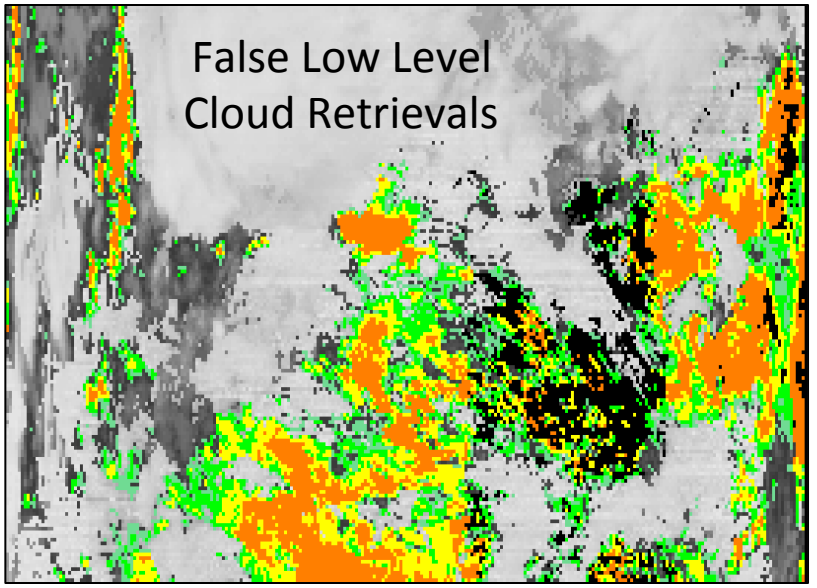


Terra Band 5

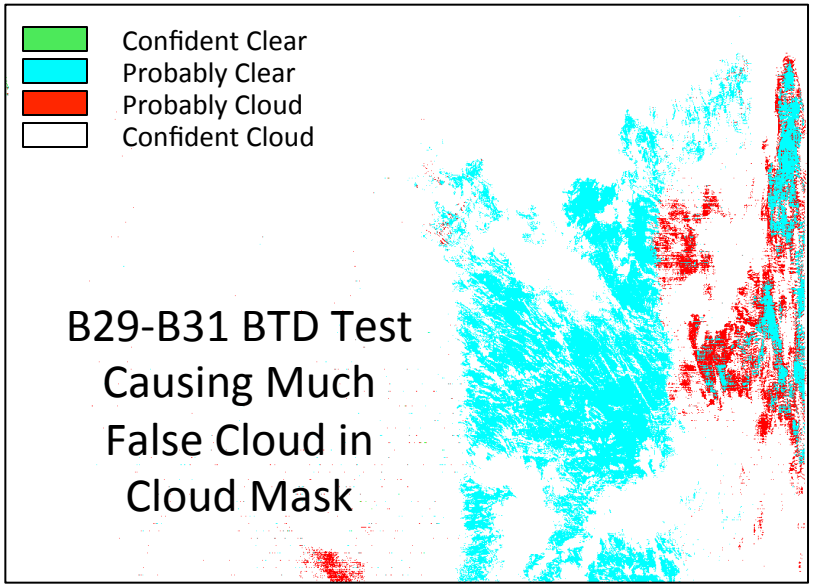


Terra Band 31

Cloud Top Pressure Result



= 900 → 1000 HPa ; No retrieval



Terra Final Cloud Mask Result

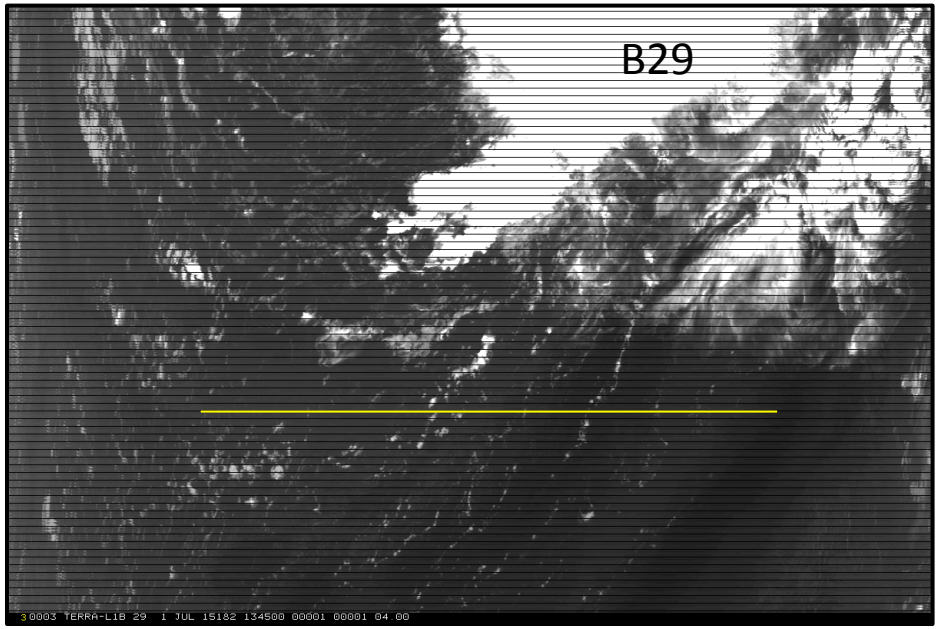
Summary of Impact on Terra MODIS L2

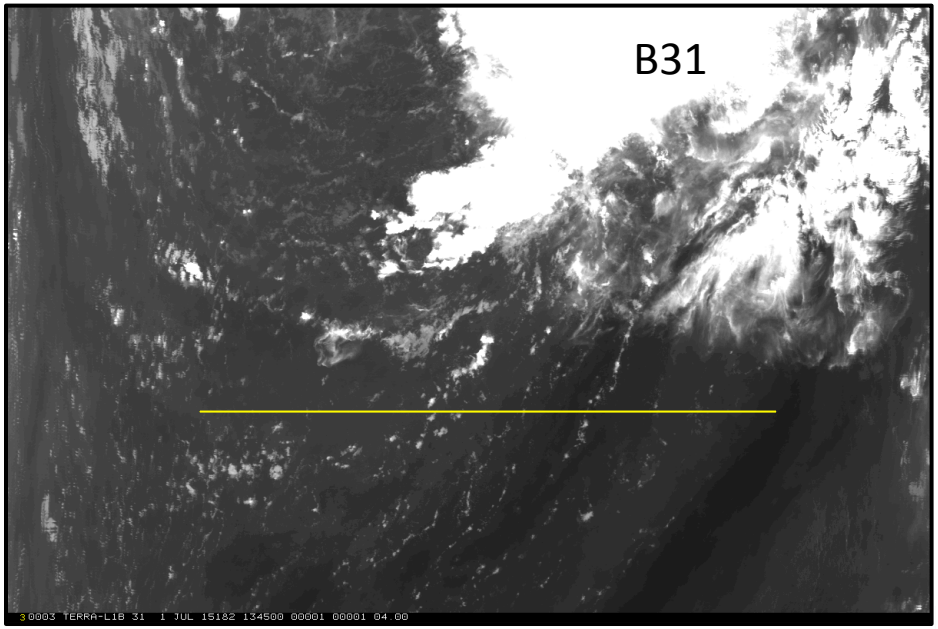
- Abundant false cloud in tropics in Cloud Mask.
- False positive trend in Cloud Fraction
- False negative trend in middle level Integrated Water Vapor.
- Increase in “Ice” and “Uncertain” (mixed) and reduction in “Water” Cloud Particle Phase retrievals.
- False “Low” cloud retrievals in Cloud Top Properties.

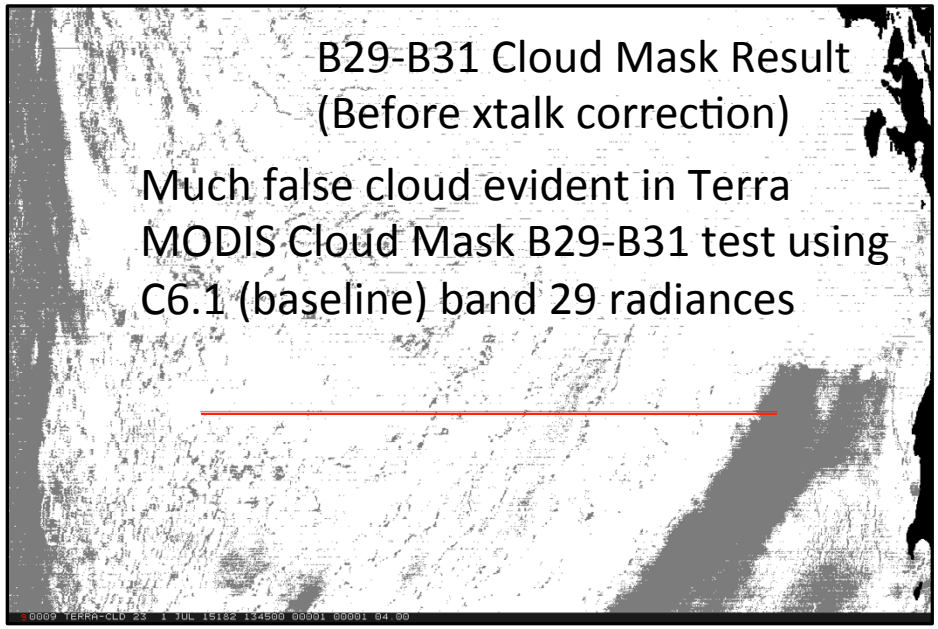
Ongoing Mitigation Efforts

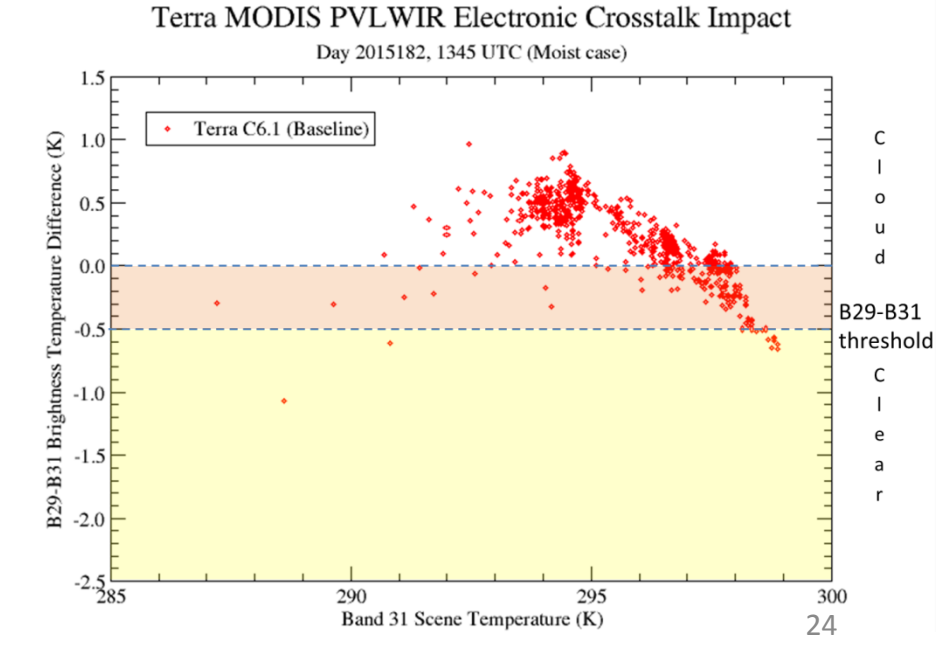
- No correction currently in C6 L1B processing.
- MCST deriving crosstalk correction coefficients using monthly lunar views supplemented with daily earth scenes.
- MCST generating crosstalk-corrected L1B granules which are being reviewed by Wisconsin.
- Aqua radiances as guidance on “Truth”.
- Cloud Mask tests using B27, 29 have been disabled through threshold adjustments in forward processing.

Terra MODIS July 1, 2015, 1345 UTC (TWP Moist Case)

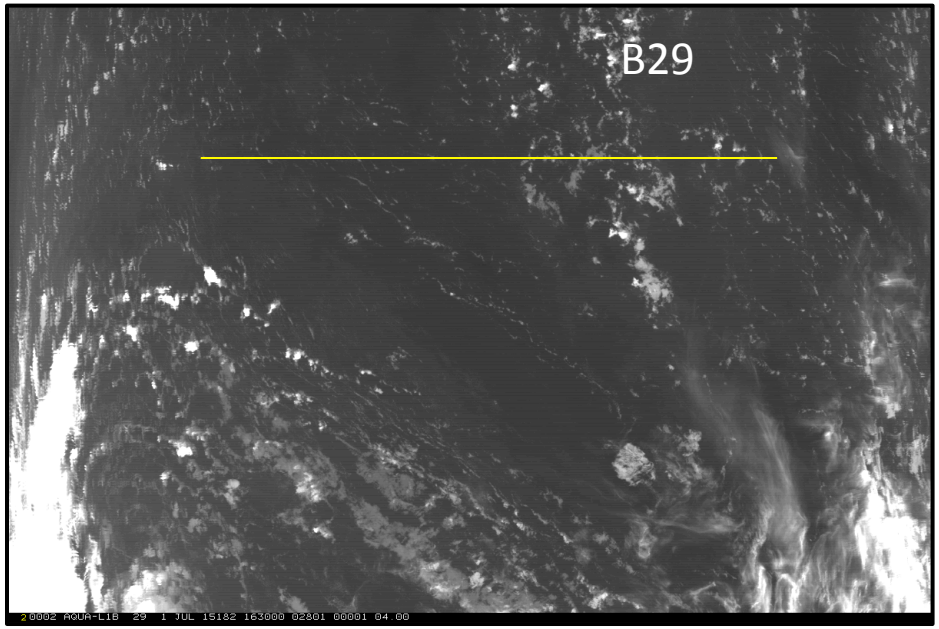


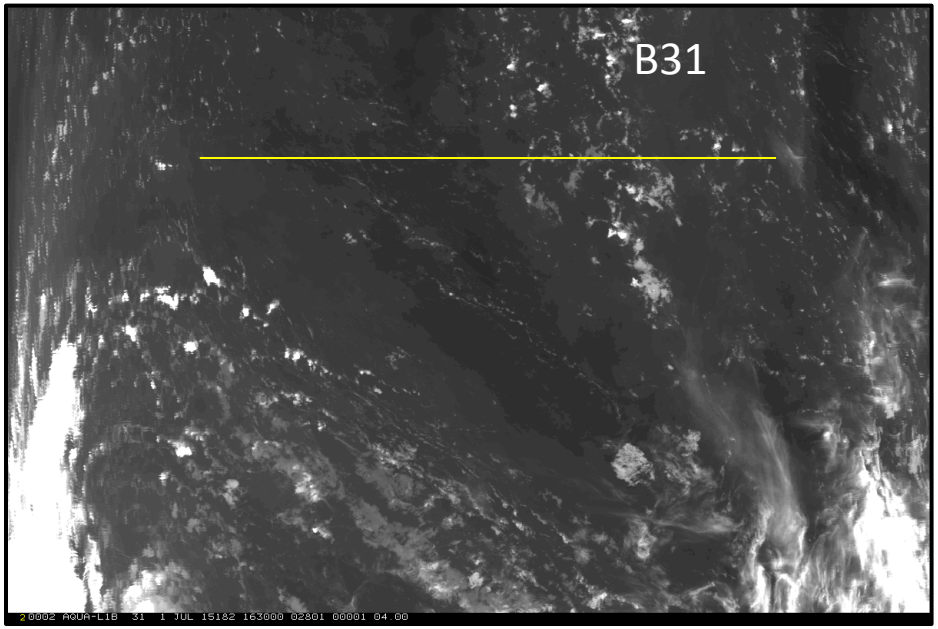


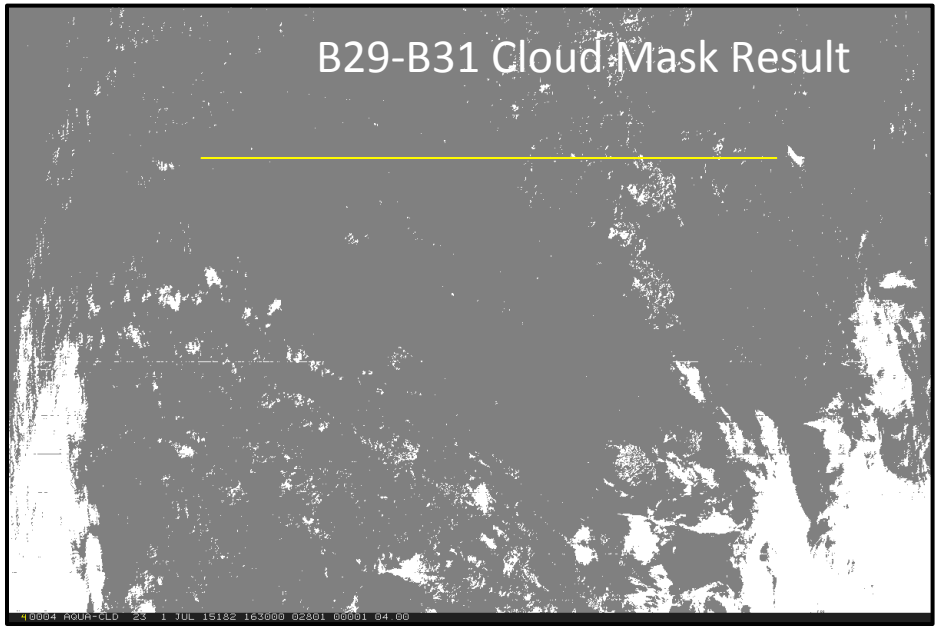


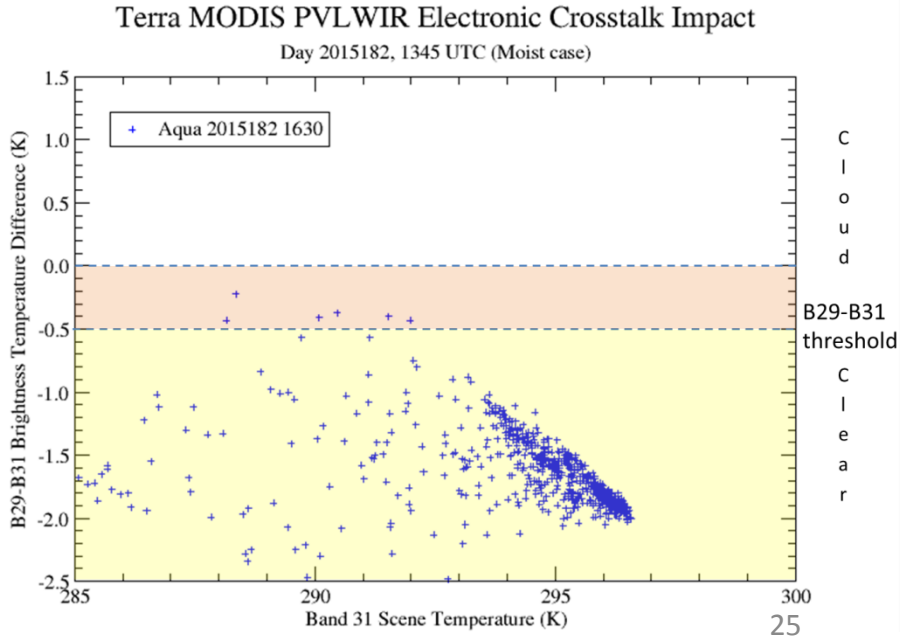


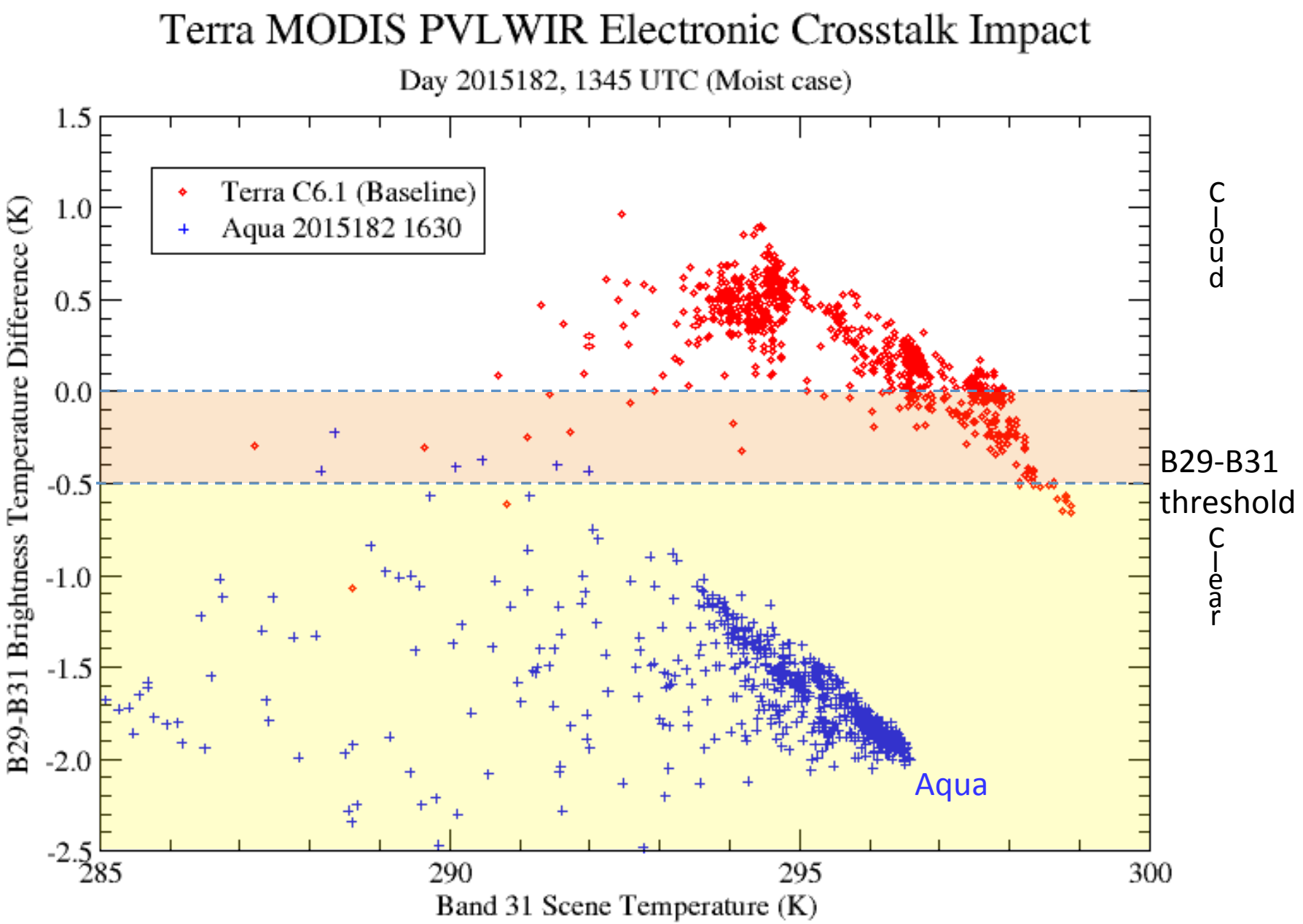
Aqua MODIS July 1, 2015, 1630 UTC (TWP Moist Case)

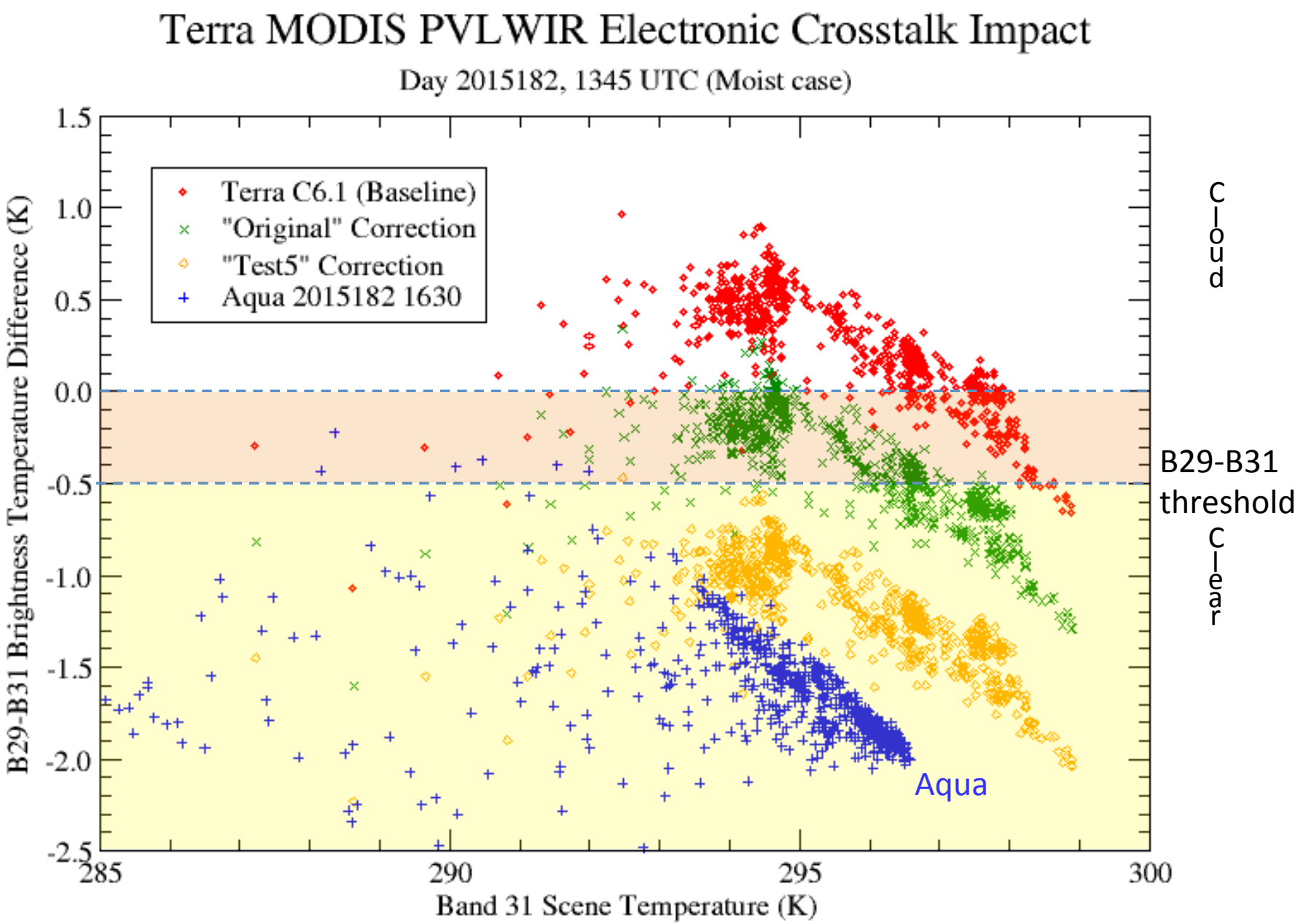









Terra MODIS PVLWIR Electronic Crosstalk Impact
Day 2015182, 1345 UTC (Moist case)
Terra C6.1 (Baseline)
Aqua 2015182 1630
B29-B31 Brightness Temperature Difference (K)
Band 31 Scene Temperature (K)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
285
290
295
300
Aqua
Cloud
B29-B31 threshold
Clear


Terra MODIS PVLWIR Electronic Crosstalk Impact
Day 2015182, 1345 UTC (Moist case)
Terra C6.1 (Baseline)
"Original" Correction
"Test5" Correction
Aqua 2015182 1630
B29-B31 Brightness Temperature Difference (K)
Band 31 Scene Temperature (K)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
285
290
295
300
Aqua
Cloud
B29-B31 threshold
Clear

Path Forward

- Additional B29 pre-Safe Mode case studies in different regions of the World (underway)
- Global day(s) L1B test data set using "maturing" B29 crosstalk correction coefficients, likely with PGE03 as well
- Apply methods to B27, B28, and B30.
- Develop and evaluate post-Safe Mode crosstalk correction
- *Implement in forward processing (TBD)*
- *Reprocess entire Terra MODIS data record (TBD)*

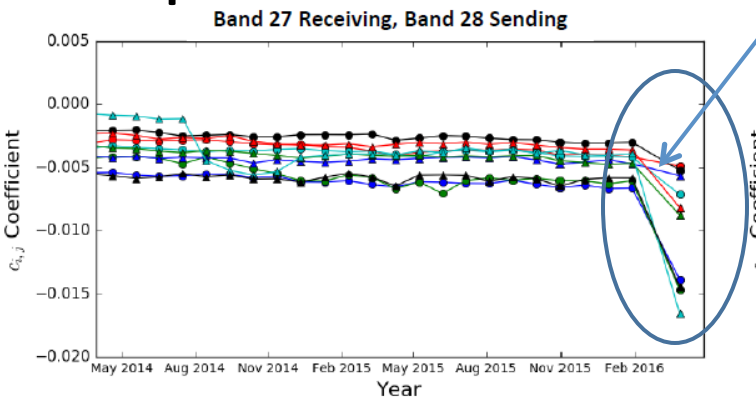
Summary

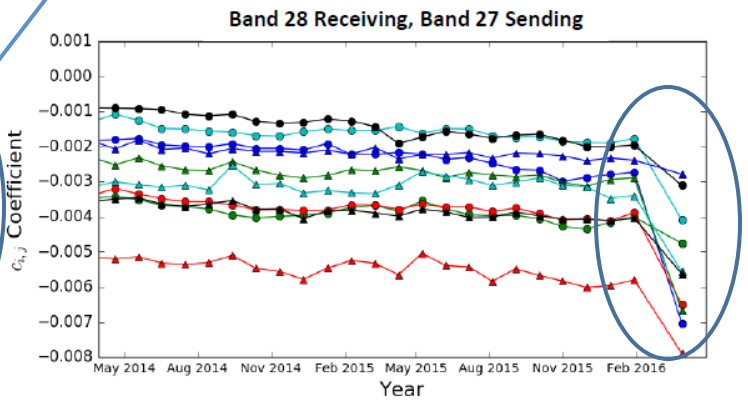
- Electronic Crosstalk in Terra MODIS bands 27-30 likely root cause of drift in PVLWIR L1B radiances.
- Impact has shown up in Cloud Mask (MOD35), Integrated Water Vapor (MOD07), Cloud Phase and Cloud Top Pressure (MOD06) products, placing at risk the climate quality status of these geophysical products.
- Mitigation strategy underway, led by MCST. Global efficacy TBD, but encouraging results in B29 testing in the tropics. Post-Terra Safe Mode behavior under study.

Backup

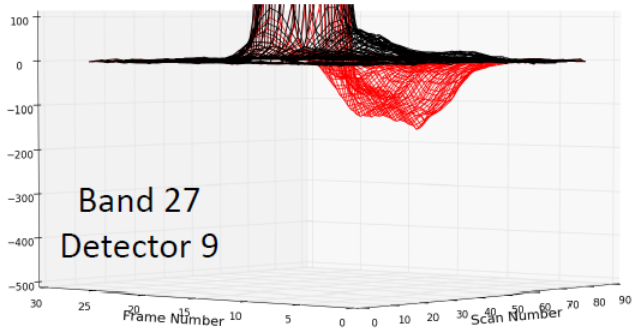
- PVLWIR crosstalk behavior before and after Feb 2016 Terra Safe Mode
  - Increase in crosstalk amplitude countered by adjustment in crosstalk correction coefficients of all bands
  - Early testing suggests that adjusted crosstalk correction coefficients effective at removing most of the crosstalk signal (similar to before Safe Mode)
  - More lunar cycles needed to track and confirm behavior

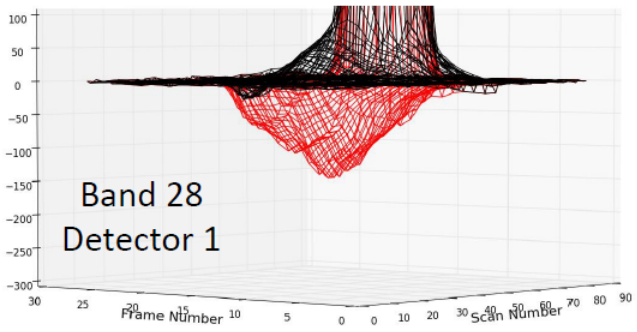
Impact of Feb 2016 Terra Safe Mode



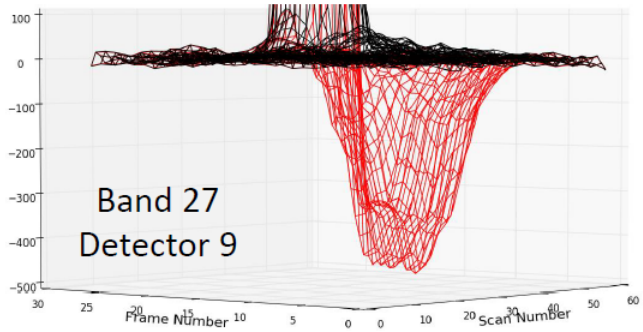


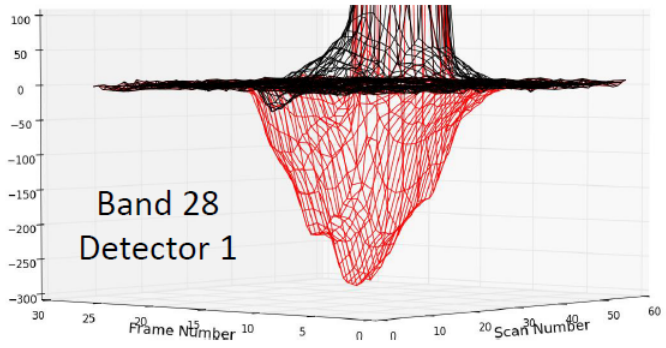
Before Safe Mode (01-28-2016)





After Safe Mode (03-28-2016)

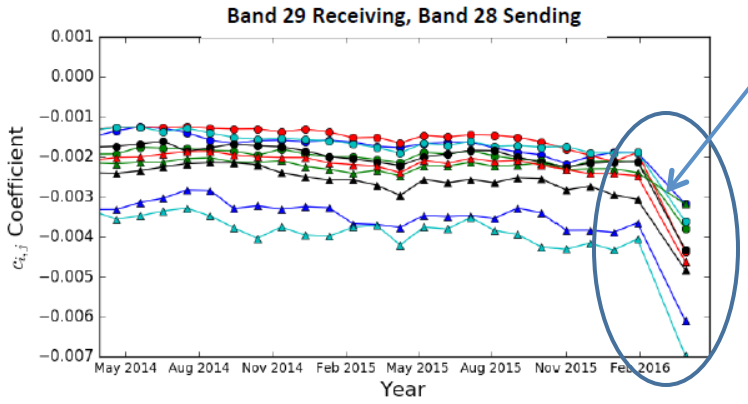


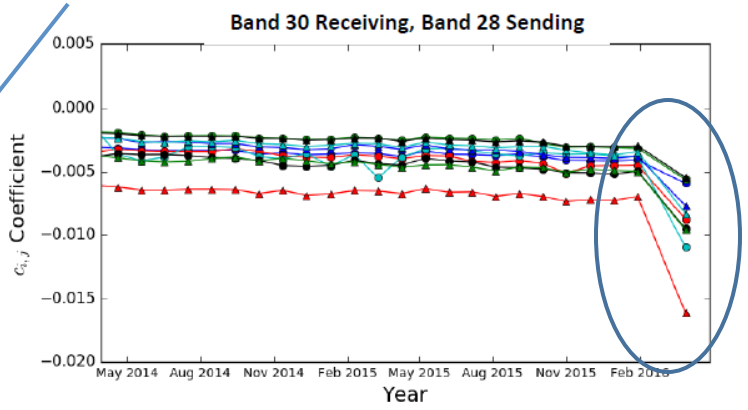


Lunar data

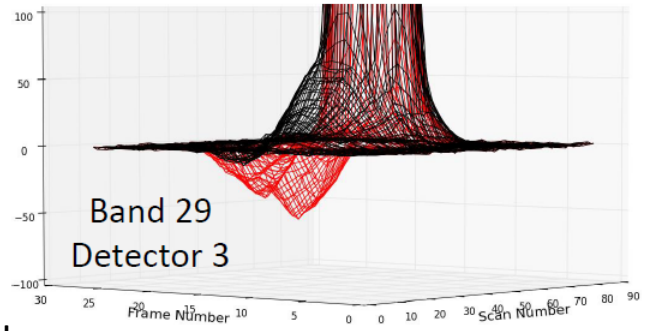
- Uncorrected
- Crosstalk Corrected

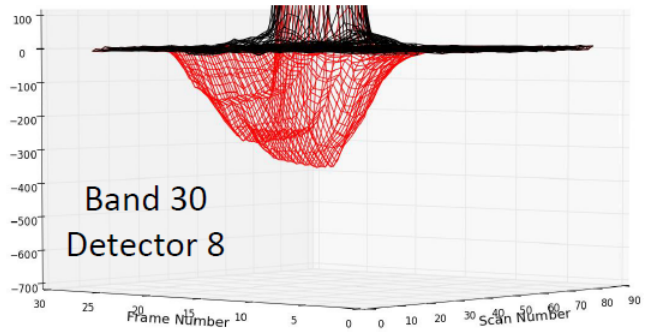
Impact of Feb 2016 Terra Safe Mode





Before Safe Mode (01-28-2016)





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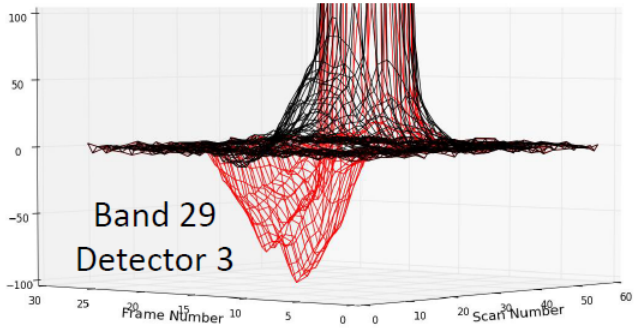

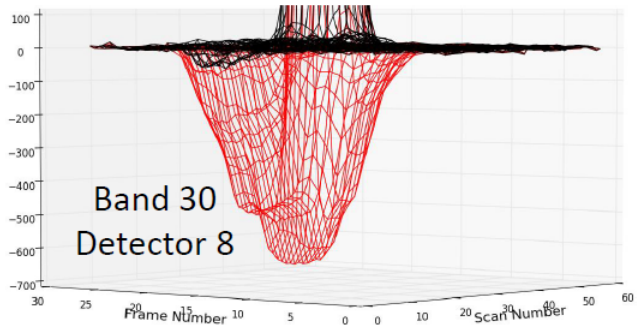

Lunar data:

- Uncorrected
- Crosstalk Corrected